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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/652,796

08/28/2003

Justin K. Brask

42P17280

2002

7590

02/07/2005

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EXAMINER

DOLAN, JENNIFER M

ART UNIT

PAPER NUMBER

2813

DATE MAILED: 02/07/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/652,796

Applicant(s)

BRASK ET AL.

Examiner

Jennifer M. Dolan

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 12-20 is/are allowed.
- 6) ☒ Claim(s) 1, 6-9, 11 is/are rejected.
- 7) ☒ Claim(s) 2-5 and 10 is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 8/28/03 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. ____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>8/28/03; 11/6/03</u> . | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

2. Claims 1, 6-8, 9, and 11 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent No. 6,743,643 to Joshi et al.

Regarding claim 1, Joshi discloses a method for making a semiconductor device comprising: forming a metal oxide layer on a substrate, converting at least part of the metal oxide layer to a metal layer (see column 2, lines 40-64; column 1, lines 10-20), and oxidizing the metal layer to generate a metal oxide high-k gate dielectric layer (column 3, lines 15-25).

Regarding claims 6-8, Joshi discloses that the metal oxide layer is converted to a metal layer through exposure to a hydrogen containing gas or a hydrogen based plasma (column 2, lines 52-64).

Regarding claims 9 and 11, Joshi discloses using an oxidizing agent that is a gas containing oxygen (column 3, lines 15-25).

3. Claims 1, 6, 8, 9, and 11 are rejected under 35 U.S.C. 102(e) as being anticipated by U.S. Patent Publication No. 2004/0092073 to Cabral, Jr. et al.

Regarding claim 1, Cabral discloses a method for making a semiconductor device comprising: forming a metal oxide layer on a substrate (paragraphs 0002, 0008), converting at least part of the metal oxide layer to a metal layer (paragraph 0008; forming gas anneal causes reduction in metal oxide); and oxidizing the metal layer to generate a metal oxide high-k gate dielectric (paragraph 0008).

Regarding claims 6 and 8, Cabral discloses exposing the metal oxide layer to a hydrogen containing gas (paragraph 0008).

Regarding claims 9 and 11, Cabral discloses oxidizing the metal layer using an oxygen-containing gas (paragraph 0008).

Allowable Subject Matter

4. Claims 12-20 are allowed.
5. Claims 2-5 and 10 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.
6. The following is a statement of reasons for the indication of allowable subject matter:

The primary reason for allowability is that although a process of forming a metal oxide, reducing the metal oxide in part to a metal layer, and then re-oxidizing is known in the art, the prior art generally teaches such a process as undesirable, and generally teaches the reducing step as an undesired inherent by-product of hydrogen passivation of the MOSFET, rather than as a desired step. Hence, regarding claims 12-20, although it is common that metal oxide layers

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deposited by a CVD or ALD process would have halide impurities due to the typical precursors, there is no suggestion of reducing such a metal oxide layer to a metal layer, and then re-oxidizing. Since the prior art generally teaches that a reduction followed by a re-oxidation of a metal oxide is undesirable, and since the present invention teaches that performing such steps on a halide-containing metal oxide has the beneficial and unexpected advantage of eliminating halide impurities in the metal oxide film, it is the examiner's opinion that the methodology presented in claims 12 and 18 would not have been obvious to a person having ordinary skill in the art.

Regarding claims 2-5 and 10, the examiner recognizes that parameters such as forming a metal oxide of a specified thickness, using polysilicon or metal for the gates, and using hydrogen peroxide or ozone for re-oxidation of a metal layer are generally known in the art. However, it is the examiner's opinion that since the prior art only teaches the reduction of the metal oxide to a metal layer as an undesired by-product of passivation, and re-oxidation of the metal oxide as an undesirable means for repairing the oxygen vacancies in the metal oxide, it is not reasonable to modify an undesirable embodiment of the prior art to meet the limitations in claims 2-5 and 10.

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

- a. U.S. Patent Publication No. 2002/0175358 to Yamamichi discloses a method using annealing in a deuterium atmosphere, rather than a hydrogen atmosphere, to avoid hydrogen degradation of the metal oxide layer.

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- b. U.S. Patent Publication No. 2003/0113972 to Hayashi et al. discloses a method including depositing a metal layer, and then oxidizing to form a thin metal oxide.
- c. U.S. Patent No. 6,737,341 to Yamamoto et al. provides general teachings on oxidation tendencies of silicon and various metals.
- d. U.S. Patent No. 6,165,802 to Cuchiaro discloses superlattice structures for minimizing hydrogen degradation during hydrogen anneals.
- e. U.S. Patent Publication No. 2004/0033661 to Yeo et al. discloses using vacuum annealing to remove impurities and densify a metal oxide layer.
- f. U.S. Patent No. 6,140,198 to Liou discloses using a reduction and/or re-oxidation process to control the resistivity of a metal oxide layer used for resistors.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Dolan whose telephone number is (571) 272-1690. The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl W. Whitehead, Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jennifer M. Dolan
Examiner
Art Unit 2813

jmd

Craig A. Thompson
CRAIG A. THOMPSON
PRIMARY EXAMINER